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ANALYSES AND HEATING VALUES OF ILLINOIS COALS.

Through the courtesy of Professor S. W. Parr, University of Illinois, a very interesting presentation is here given of the chemical analyses and heating values of the different grades of coal of Illinois.

The secretary of the Bureau of Labor Statistics desires to hereby present public acknowledgement to Professor Parr and his associates, of the University of Illinois, for this very valuable contribution to the statistics of coal in this State.

The article and tables follow:

THE CHEMICAL ANALYSES AND HEATING VALUES OF ILLINOIS COALS.

[By S. W. Parr, Professor of Applied Chemistry, and F. C. Koch, Instructor in Chemistry, University of Illinois, Urbana, Ill.]

The proximate analysis of Illinois coals made at the University of Illinois from the year 1878 to the present time are herewith presented in tabular form. There have been included also results from other sources so far as they have been accessible and seemed to be reliable. The value of such data is indicated from the constant inquiries for the same, and we are under obligations to Honorable David Ross, secretary of the Bureau of Labor Statistics, for making it thus available for general reference. It is to be regretted that the work has been of such haphazard and unsystematic a nature, and it is sincerely hoped that the presentation of this summary will stand as a somewhat severe reflection against the great State of Illinois for what she has not done in connection with her coal interests. Standing second only to Pennsylvania in the amount and value of her coal output, she still lacks even the most rudimentary attempt at a scientific or economic study of her mineral resources while our neighbors have made very complete and valuable surveys.

The most serious defect in the work here presented is the variable methods of taking the samples. Those taken by W. D. Rudy in 1878 are stated to have been taken at the mine by cutting across the face of the vein (Uni. of Ill. Report 1878.) These number seventeen and

have been labeled "vein samples." The next work at the University was done by R. B. McConney and F. H. Clark in 1889 in connection with a theses on the "Heating Power of Illinois Coals." These samples were taken from carload lots, but there is no statement indicating the size of coal, lump, slack, etc. However, since the use of slack under boilers at that time was a somewhat unusual practice, but recently taken up by electric lighting plants, and since the uniform custom at the University then was to purchase lump coal, it is fair to assume that these 29 samples are all "lump." The analyses dated 1895, 1896 and 1897 were mainly from car lots, sampled in connection with boiler tests, conducted at the University by the department of Mechanical Engineering under the direction of Professor L. P. Breckenridge.

The analytical results have all been obtained according to established methods, and are given in percentages.

Moisture.—As is the general custom in this country, these percentages refer to the commercially dry coal, that is, the coal as it comes from the mine, and is supposed to reach the consumer without the addition or extraction of water. It is to be noted that there is a difference between "commercially dry" and "oven" or "chemically" dry coal. A sample may be to all appearance dry, yet upon heating for an hour at the temperature of boiling water or slightly above, there is removed a certain amount of water which has been held in some invisible or combined state. This water varies greatly with different coals, being rarely below three or four per cent, and sometimes reaching as high as 12 per cent, the average being perhaps seven or eight per cent.

In the coals of Europe a marked difference exists in this respect; an amount of water exceeding three or four per cent being unusual, while the average is two or three per cent. Much the same condition prevails with the soft coals and semianthracities of the eastern United States, while the brown coals or lignites of both Europe and America have a high percentage of water, averaging 12 to 15 per cent. It is probable then that coals of the Mississippi Valley stand geologically midway between the anthracite coals of the east and the lignites of the south and northwest.

Ash.—The content of moisture together with the ash constitutes the inert material of the coal. Indeed, these ingredients are not only inert, but to a certain degree negative in their effect; for example, the heat necessary to bring the water up to the vapor point is held by the

steam thus formed and carried away and lost. The ash also tends to prevent a full and complete combustion of the coal and may carry away mechanically, unburnt material. It is evident, therefore, that in proportion as these constituents are high in amount, there is a decrease in value, both on account of the inert material as also from the negative property of the same.

Combustible Material.—The remaining constituents after the water and ash, we may consider in general as combustible material. This divides sharply into two classes, that which easily volatilizes and becomes gaseous and that remaining fixed and burning as coke. Because, of the ready volatility of the first, it is liberated in great volume when fresh coal is added to a free fire. Because, the admission of air is regulated for the average conditions, much of this gaseous product is unsupplied with the necessary oxygen and so passes off unburned. For this and other reasons it is evident that the greatest efficiency is likely to be gotten out of those coals lowest in volatile matter and highest in fixed carbon, but it may fairly be asked whether this is not a fault in the method of burning rather than in the coal itself. The volatile constituents of the coal begin passing off at about 700 degrees Fah. and the process when once started is very rapid for the major part of the gaseous constituents. It is just at this time when insufficient oxygen results in incomplete combustion, which is made evident to the eye by dense volumes of smoke. But the problems connected with perfect combustion and avoidance of smoke are many and varied, and can not be entered into here. The point only is made that at present, with our faulty methods, we get a higher ratio of the heat content out of those coals having the lowest volatile constituents, and we lose the most in case of coals which are relatively low in fixed carbon.

Heat Value—This brings us to the question of calorific value. One pound of coal in burning is capable of raising one pound of water a certain number of degrees. These degrees (Fah.) are called the British Thermal Units. This is the theoretical or actual heat possibility of a coal. Practically, by reason of faulty combustion and loss of heat in various ways, only a part of this theoretical heat content is utilized, the average steam boiler having perhaps an efficiency of 60 per cent. From the above it will be evident how desirable it is to determine in all cases the actual calorific content of a coal. Methods for determining this factor are numerous. If the amount of carbon and hydrogen available for combustion are known a simple calculation,

based on the known heat values of these constituents according to Dulong's formula, will give the calorific value thus: $14600 C + 62000$

$\frac{O}{8} (H. - \frac{O}{8})$ in which C, H, and O refer to the amounts of carbon, hydrogen and oxygen respectively, the numerical coefficients being the accepted heat values for carbon and hydrogen. This requires an ultimate analysis of the coal, a somewhat elaborate process, and requiring the services of an expert chemist to perform.

In table II are given the results of such analyses of Illinois coals so far as they are available.

Various instruments for indicating directly the calorific values have been devised, but general use has not been made of them which the importance of the subject demands. This has no doubt resulted, in the case of some of the forms of instruments, from the unreliable and faulty readings obtained. A new type of calorimeter, devised by one of us (Parr JNL. Am. Chem. Soc. Vol. XXII) because of its simplicity and accuracy, has greatly extended the number of calorific determinations, and it is hoped will give a new impetus as also a valuable aid to the study of coal combustion.

Sulphur—Sulphur occurs in coal chiefly as iron pyrites, sulphate calcium, and sulphur, organically combined with the coal. The first is chiefly responsible for the formation of clinker. In the manufacture of gas, part of the sulphur passes off in some volatile combination. If this combination is organic as carbon bisulphide ($C S_2$) it is not removed in the process of purification, whereas, in other forms as sulphuretted hydrogen ($H S_2$) it is removed with comparative ease. Hence, for the purposes of gas manufacture, it is not so much the amount of sulphur as the condition or combination. Moreover the usual belief that half of the sulphur passes off with the gas and half remains in coke is erroneous, at least for Illinois coals. This is well illustrated in Table III. There is here offered a very suggestive field of study for the gas manufacturer.

Coke—That the coking of Illinois coals is possible has been demonstrated by recent developments in that line. Since the use of this product is chiefly metallurgical the sulphur question is an important one. Here again some suggestive facts are offered in Table III. The percentages of fixed carbon in Table I, plus the ash content, give roughly the amount of coke available, though smaller than should be realized in practice, since in the process of coking much of the carbon of the volatile matter is "fixed" or made a part of the coke. The tables referred to follow:

TABLE I.—*Chemical Analyses and Heating Values of Illinois*

Number.	LOCATION OF MINE.		Description or grade of coal used.	Geological number of seam.	DATE OF ANALYSIS.	
	Town.	County.			Month.	Year.
1	Assumption.....	Christian	Block	1	.....	1889
2	"	"	Lump	1	.....	.....
3	"	"	Average	1	.....	.....
4	Astoria	Fulton .....	.....	5	January.....	1898
5	Athens	Menard.....	.....	5	.....	1897
6	" .....	" .....	.....	5	March.....	1897
7	Auburn	Sangamon....	Screenings.....	5	.....	.....
8	Augusta.....	Hancock .....	.....	2	July	1898
9	Barclay	Sangamon....	.....	5	.....	.....
10	"	"	Vein sample.....	5	.....	1878
11	Belleville.....	St. Clair.....	.....	6	.....	.....
12	Murphysboro.....	Jackson .....	.....	7	.....	.....
13	" .....	" .....	.....	7	.....	.....
14	" .....	" .....	.....	7	.....	.....
15	" .....	" .....	.....	7	.....	.....
16	" .....	" .....	.....	7	.....	.....
17	" .....	" .....	.....	7	.....	.....
18	" .....	" .....	.....	7	.....	1889
19	Bloomington.....	McLean.....	Vein sample.....	5	.....	1878
20	"	"	Lump	5	.....	1896
21	" .....	" .....	.....	5	.....	1889
22	Briar Bluff.....	Henry.....	Vein sample.....	1	.....	1878
23	Bryant.....	Fulton	Average.....	5	.....	.....
24	"	"	Select.....	5	.....	.....
25	Buckhart.....	"	Average.....	5	.....	.....
26	"	"	Select.....	5	.....	.....
27	Canton	"	Average.....	5	.....	.....
28	"	"	Select.....	5	.....	.....
29	Carbondale.....	Jackson	Vein sample.....	7	.....	1878
30	" .....	" .....	.....	7	.....	.....
31	" .....	" .....	.....	7	May	1896
32	" .....	" .....	.....	7	.....	1896
33	Cartersville.....	Williamson....	Mine run	7	.....	1900
34	"	"	Washed, No. 1.....	7	.....	1900
35	"	"	" No. 2.....	7	.....	1900
36	"	"	" No. 3.....	7	.....	1900
37	"	"	" No. 4.....	7	.....	1900
38	"	"	Dust from washer.....	7	.....	1900
39	"	"	Washed, No. 2.....	7	March.....	1898
40	" .....	" .....	.....	7	.....	1898
41	Catlin.....	Vermilion....	Vein sample.....	7	.....	1878
42	Centralia.....	Marion.....	.....	6	.....	1889
43	"	"	Duff	6	.....	.....
44	" .....	" .....	.....	6	.....	.....
45	Claire.....	Fulton	Average.....	5	.....	.....
46	"	"	Select.....	5	.....	.....
47	Colchester.....	McDonough....	.....	2	July	1898
48	" .....	" .....	.....	2	.....	.....
49	"	"	Slack.....	2	.....	.....
50	Colfax	McLean.....	Nut, No. 2.....	6	.....	.....
51	Collinsville.....	Madison.....	.....	6	.....	.....
52	Cuba	Fulton	Average.....	5	.....	.....
53	"	"	Select.....	5	.....	.....
54	" .....	" .....	.....	5	July.....	1898
55	Danville	Vermilion....	Vein sample.....	7	.....	1878

Coals, Comprising 260 Tests from 94 Different Locations.

PROXIMATE ANALYSIS.				Sulphur.	British thermal units per pound of coal.	Calorimeter used.	AUTHORITY.		Number.
Moisture.	Volatile matter	Fixed carbon.	Ash.				Institution.	Chemist.	
3.90	41.20	50.10	4.80	....	13,068	L. Thompson.....	University of Ill.	Clark.....	1
7.25	37.76	47.86	7.13	2.94	.....	.....	..	L. Smith.....	2
7.97	37.24	43.56	11.23	5.21	.....	.....	..	.....	3
12.26	40.00	39.40	8.34	3.16	11,025	L. Thompson.....	..	Wolcott.....	4
10.01	35.57	43.60	10.82	2.40	.....	.....	..	L. Smith.....	5
12.11	35.18	41.95	10.76	....	12,150	L. Thompson.....	..	.....	6
*	37.50	47.30	15.20	....	11,193	Carpenter.....	..	Carpenter.....	7
10.78	44.37	41.32	3.53	2.48	11,745	L. Thompson.....	University of Ill.	Wolcott.....	8
7.40	35.70	46.20	10.70	....	11,205	.....	..	McConney.....	9
10.08	27.32	45.60	17.00	3.21	.....	.....	..	Rudy.....	10
7.05	33.05	50.40	9.50	....	.....	.....	..	.....	11
4.85	31.39	57.80	5.46	2.75	.....	.....	..	.....	12
6.12	30.05	53.74	9.19	1.22	11,529	.....	..	Eng. Club, St.L	13
6.35	31.50	55.25	6.90	2.02	12,657	.....	..	.....	14
7.39	28.28	53.87	10.46	.98	11,466	.....	..	.....	15
5.85	31.84	55.72	6.59	2.92	11,781	.....	..	.....	16
6.02	32.86	53.89	7.73	1.09	.....	.....	University of Ill.	L. Smith.....	17
7.85	32.15	56.00	4.00	....	12,825	L. Thompson.....	..	Clark.....	18
7.90	34.02	53.12	4.96	1.97	12,319	Cal. from ult. anal..	..	Rudy.....	19
3.80	43.90	43.50	8.80	....	11,970	L. Thompson.....	..	Parr.....	20
4.10	35.99	45.20	14.71	....	11,313	.....	..	McConney.....	21
12.60	28.96	48.54	9.90	4.62	.....	.....	..	Rudy.....	22
2.42	32.91	42.69	22.03	3.16	9,940	.....	..	Forsyth.....	23
3.88	38.05	48.75	9.32	....	11,835	.....	..	.....	24
6.14	29.94	46.27	17.65	....	10,258	.....	..	Forsyth.....	25
8.92	33.52	48.06	9.50	....	11,284	.....	..	.....	26
3.51	36.99	46.69	12.81	....	10,945	.....	..	Forsyth.....	27
4.40	38.32	48.09	9.19	....	11,584	.....	..	.....	28
6.32	26.40	59.88	7.40	.80	12,323	Cal. from ult. anal..	University of Ill.	Rudy.....	29
4.25	33.65	57.50	4.60	....	12,582	L. Thompson.....	..	Clark.....	30
6.08	39.78	46.22	7.92	....	11,070	.....	..	Parr.....	31
6.18	34.10	49.12	10.60	....	11,430	.....	..	.....	32
4.87	34.11	52.17	8.85	.85	12,214	Parr.....	..	Kock.....	33
4.66	33.99	54.21	7.14	.74	12,286	.....	..	.....	34
4.31	35.12	55.01	5.56	.86	12,934	.....	..	.....	35
3.98	34.66	53.04	8.32	.87	.....	.....	..	.....	36
4.86	33.26	55.29	6.59	1.15	12,345	Parr.....	University of Ill.	.....	37
5.50	32.97	50.01	8.52	1.16	.....	.....	..	.....	38
5.76	30.25	57.32	6.67	1.18	12,420	L. Thompson.....	University of Ill.	Kock.....	39
7.35	34.20	52.34	6.11	1.05	11,781	.....	..	.....	40
7.80	31.08	48.42	12.70	3.96	.....	.....	..	Rudy.....	41
8.28	38.18	45.50	8.04	....	.....	L. Thompson.....	..	McConney.....	42
1.50	36.10	36.00	26.40	4.04	.....	.....	..	.....	43
4.88	35.59	40.11	19.42	3.58	9,983	.....	..	.....	44
3.16	32.94	43.05	20.85	....	.....	.....	..	Forsyth.....	45
5.27	37.30	48.21	9.22	....	11,795	.....	..	.....	46
9.04	34.07	40.09	16.80	1.16	10,600	L. Thompson.....	University of Ill.	Wolcott.....	47
11.60	25.02	44.76	18.62	....	9,849	.....	..	Eng. Club, St.L	48
5.30	25.48	38.12	31.10	1.20	9,035	.....	..	.....	49
2.61	41.36	36.96	19.07	4.19	.....	.....	..	.....	50
9.20	45.89	31.57	13.34	5.34	10,143	.....	..	Eng. Club, St.L	51
4.17	36.38	48.62	10.83	....	11,370	.....	..	Forsyth.....	52
6.59	35.85	49.91	7.65	....	11,582	.....	..	.....	53
10.42	36.93	40.96	11.69	4.60	10,800	L. Thompson.....	University of Ill.	Wolcott.....	54
9.60	31.20	44.56	14.64	2.72	.....	.....	..	Rudy.....	55

* Dried.

TABLE I.—*Chemical Analyses and Heating Values of Illinois Coals.*

Number.	LOCATION OF MINE.		Description of grade of coal used.	Geological number of seam.	DATE OF ANALYSIS.	
	Town.	County.			Month.	Year.
56	Danville	Vermilion		7		
57	"	"		7		
58	"	"		7		
59	"	"		7		
60	"	"	Screenings	7	May	1896
61	"	"	Lump	7	March	1900
62	"	"		7	"	1900
63	Dawson	Sangamon	Pea	5	"	1899
64	"	"		5	"	1899
65	Desota	Jackson	Mine run	7	November	1899
66	"	"	No. 1 washed	7	"	1899
67	"	"	No. 2 washed	7	"	1899
68	"	"	No. 3 washed	7	"	1899
69	"	"	No. 4 washed	7	"	1899
70	"	"	Refuse from water	7	"	1899
71	Divernon	Sangamon	Lump	5	May	1901
72	Dunfermline	Fulton	Average	5		
73	"	"	Select	5		
74	"	"	Slack	5		
75	"	"		5	June	1898
76	"	"		5		
77	Duquoin	Perry		6		1897
78	"	"	Vein sample	6		1878
79	"	"		6		
80	"	"	Nut	6		
81	"	"		6		
82	"	"		6		
83	"	"	Lump	6	February	1895
84	"	"		6	September	1895
85	"	"		6	June	1896
86	"	"	Slack	6	May	1898
87	"	"		6	January	1895
88	"	"	Lump	6		
89	"	"		6		
90	"	"	Pea	6		
91	"	"	Jupiter	6		
92	Edwards	Peoria	Average	5		
93	"	"		5		
94	"	"	Select	5		
95	"	"		5		
96	Elmwood	"		2	July	1898
97	"	"	3d vein	2	"	1898
98	"	"	5th vein	2	"	1898
99	"	"	6th vein	2	"	1898
100	"	"	Average	2		
101	"	"	Select	2		
102	"	"	Vein sample	2		1878
103	Fairmount	Vermilion	Screenings	7	December	1896
104	"	"		7		
105	Farmington	Fulton	Average	5	July	1898
106	"	"	Select	5		
107	"	"	Select	5		
108	"	"	Vein sample	5		1878
109	Fiatt	"		5	July	1898
110	Forest	Livingston	Drill core, vein 1	5	October	1898
111	"	"	Drill core, vein 2	+		1898
112	Galva	Henry		6	July	1898
113	Gilchrist	Mercer		1		1898
114	"	"		1		
115	Gillespie	Macoupin		5		
116	"	"		5		
117	"	"	Average	5		
118	Girard	"		5		
119	"	"		5		
120	"	"	Pea	5		
121	Glen Carbon	Madison	Lump	6	May	1901
122	Grape Creek	Vermilion	Vein sample	6	July	1878
123	Greenview	Menard		5		1900
124	Greenridge	Macoupin		5		

Comprising 260 Tests from 94 Different Locations—Continued.

PROXIMATE ANALYSIS.				Sulphur.	British thermal units per pound of coal.	Calorimeter used.	AUTHORITY.		Number.
Moisture.	Volatile matter	Fixed carbon.	Ash.				Institution.	Chemist.	
6.40	33.23	51.12	9.25	3.12	12.506	L. Thompson	University of Ill.	McConney	56
4.78	43.70	45.37	6.15	....	11.655	..	..	Clark	57
5.62	37.07	46.42	10.88	....	12.285	..	..	Parr	58
11.00	32.35	53.00	3.65	....	9.360	..	..	Koch	59
9.40	33.30	34.20	23.10	....	3.93	..	..	Johnson	60
7.56	47.47	40.50	4.47	3.62	12.20	..	..	Koch	61
8.06	40.64	47.37	3.93	1.27	10.42	..	..	..	62
12.54	33.65	41.40	12.41	5.09	8.06	..	..	..	63
9.38	35.25	43.17	12.20	2.83	8.32	..	..	..	64
4.32	34.08	51.18	10.42	1.46	9.52	..	..	..	65
5.27	34.63	52.04	8.06	1.73	7.95	..	..	..	66
4.34	35.72	51.62	8.32	2.03	45.76	..	..	..	67
4.32	36.76	49.40	9.52	1.70	18.00	..	..	..	68
3.82	35.77	52.46	7.95	2.28	10.262	Parr	..	..	69
2.88	22.71	28.65	18.00	6.03	10.471	..	..	..	70
8.69	34.72	38.59	19.06	....	12.065	..	..	Forsyth	71
2.45	32.91	45.57	6.50	....	9.401	..	..	..	72
3.54	37.59	52.37	17.71	3.13	10.350	L. Thompson	University of Ill.	Wolcott	73
9.64	28.86	39.48	22.02	....	9.417	..	..	Eng. Club, St. L.	74
10.95	34.80	36.54	17.71	3.13	10.350	L. Thompson	University of Ill.	L. Smith	75
9.60	28.90	39.50	22.00	....	11.260	Cal. from ult. anal.	University of Ill.	Rudy	76
8.13	33.15	49.51	9.21	.83	10.989	L. Thompson	..	Parr	77
8.86	23.54	60.60	7.00	1.88	11.128	..	..	..	78
7.03	35.03	44.60	13.34	....	12.170	L. Thompson	University of Ill.	McConney	79
7.43	38.91	46.00	7.66	....	12.393	..	..	Clark	80
6.84	32.03	53.69	7.44	....	11.250	L. Thompson	..	Parr	81
6.67	30.35	54.08	8.90	....	11.050	..	..	..	82
7.43	39.81	45.10	7.66	....	10.989	..	..	..	83
7.59	35.77	47.53	9.11	....	12.037	L. Thompson	University of Ill.	Wolcott	84
9.14	34.61	50.85	5.40	....	10.989	..	..	Parr	85
6.05	35.95	41.60	16.40	5.14	10.945	..	..	..	86
7.02	35.03	44.56	13.39	....	10.945	..	..	..	87
3.85	37.39	48.54	10.22	1.86	10.945	..	..	..	88
1.81	36.04	44.12	18.03	3.99	10.945	..	..	..	89
3.15	38.94	39.99	17.92	3.18	10.945	..	..	..	90
11.30	30.30	49.90	8.50	.90	10.945	..	..	Eng. Club, St. L.	91
3.20	35.48	47.77	13.55	....	9.940	..	..	..	92
1.90	34.48	43.62	20.00	....	11.051	..	..	Forsyth	93
5.04	33.96	49.56	11.44	....	12.037	..	..	..	94
4.08	38.24	52.17	5.51	....	12.330	L. Thompson	University of Ill.	Wolcott	95
9.38	44.45	40.76	5.41	2.61	12.420	..	..	..	96
8.70	43.63	41.30	6.37	2.75	11.520	..	..	..	97
10.55	26.78	42.30	10.37	1.29	11.250	..	..	..	98
9.30	35.50	43.90	11.30	3.16	8.820	..	..	..	99
1.36	27.69	35.41	35.54	....	11.051	..	..	Forsyth	100
1.90	34.70	48.23	15.17	....	10.890	L. Thompson	University of Ill.	Rudy	101
7.60	27.60	55.30	9.50	2.18	11.431	..	..	Parr	102
10.67	36.46	39.85	13.02	....	10.530	..	..	Clark	103
8.10	31.83	47.05	13.05	....	10.471	..	..	Wolcott	104
11.12	35.93	36.50	16.25	3.98	11.534	..	..	Forsyth	105
3.44	33.88	45.89	16.82	....	10.890	L. Thompson	University of Ill.	Rudy	106
6.17	35.96	48.49	9.38	....	12.45	2.81	..	Wolcott	107
8.52	29.28	50.48	11.72	3.28	10.890	L. Thompson	..	..	108
12.54	35.86	40.04	11.56	4.67	10.890	L. Thompson	..	..	109
5.19	39.37	42.99	12.45	2.81	10.890	L. Thompson	..	..	110
4.36	44.83	40.04	10.77	3.76	10.080	L. Thompson	..	..	111
10.39	36.72	36.54	16.35	3.26	10.620	Parr	..	..	112
7.45	36.94	35.32	20.26	4.86	5.60	..	..	..	113
8.40	31.20	54.90	5.60	....	11.74	..	..	..	114
3.77	34.94	49.55	11.74	....	11.54	1.50	..	Eng. Club, St. L.	115
12.61	30.58	45.27	11.54	1.50	9.739	Carpenter	..	Carpenter	116
*	36.26	51.41	12.33	....	9.954	..	..	Eng. Club, St. L.	117
9.70	34.39	45.76	10.15	3.50	10.287	..	..	..	118
8.90	32.20	42.90	16.00	8.10	21.96	3.56	..	..	119
.95	36.85	40.24	12.36	4.87	11.539	Parr	Illinois Steel Co.	Koch	120
7.85	39.13	40.66	10.60	3.63	11.082	Parr	University of Ill.	Rudy	121
9.74	28.34	51.32	8.65	3.15	11.082	Parr	..	Johnson	122
10.94	39.20	41.21	8.65	3.15	11.082	Parr	..	..	123
9.26	42.22	42.17	6.35	2.62	..	..	..	..	124

* Dried.

TABLE I—*Chemical Analyses and Heating Values of Illinois Coals,*

Number.	LOCATION OF MINE.		Description of grade of coal used.	Geological number of seam.	DATE OF ANALYSES.	
	Town.	County.			Month.	Year.
125	Hentz Bluff	St. Clair		6		
126	Herrin	Williamson	Vein sample	7	October	1900
127	Ivesdale	Champaign	Drill core	7	January	1902
128	Johnson	St. Clair		6		
129	Kewanee	Henry	Vein sample	6		1878
130	Kinmundy	Marion		6		1897
131				6		
132	Ladd	Bureau		2		
133				2		
134				2		
135	Lake Creek	Williamson		7	March	1898
136	Lancaster	Peoria		7		
137	LaSalle	LaSalle		2		1889
138				2		
139	Lincoln	Logan		5		
140				5		1889
141				5		1889
142			Vein sample	5		1878
143	Lombardville	Bureau		7		1878
144	Iles Junction	Sangamon		5		
145	Mapleton	Peoria		5		
146	Morris	Grundy	Average	2		
147			Select	2		
148				2		
149	Moweaqua	Shelby	Lump	5	January	1895
150			Lump, vein 1	5	December	1895
151			Lump, vein 2			1895
152			Lump, vein 5			1895
153				5		
154	Mt. Carbon	Jackson		2		
155			Vein sample	2		1878
156	Mt. Olive	Macoupin		5		
157				5		1889
158				5		1889
159				5	February	1895
160				5		
161			Lump	5	May	1901
162	Mt. Pulaski	Logan		5		
163	Muddy Valley	Perry	Lump	6	July	1896
164	Murphysboro	Jackson		1	March	1900
165			New Kentucky	1		
166			New Kentucky nut	1		
167	Niantic	Macon	Nut	5	January	1895
168				5		1889
169				5		1889
170	Oakland	St. Clair		6		
171	Oakwood	Vermillion		7		1889
172	Odin	Marion	Lump	6	January	1895
173				6	February	1895
174				6	April	1895
175			Pea	6	July	1896
176				6	October	1896
177			Lump	6	November	1896
178				6		1896
179				6		1896
180			Slack	6	December	1896
181			Lump	6	January	1897
182			Pea	6		1897
183			Lump	6	February	1897
184				6		1897
185			Pea	6	March	1897
186				6		1898
187				6		1895
188			Pea	6		1897
189				6		1899
190				6		1899
191				6		1899
192			Lump	6	February	1896

† Borings, number of seam not determined.

Comprising 260 Tests from 94 Different Locations—Continued.

PROXIMATE ANALYSIS.					Sulphur.	British thermal units per pound of coal.	Calorimeter used.	AUTHORITY.		
Moisture.	Volatile matter	Fixed carbon.	Ash.					Institution.	Chemist.	Number.
8.95	37.81	48.24	5.00	3.30	10,332				Eng. Club, St.L.	125
4.22	34.66	51.49	9.63	2.78	11,980		Parr	University of Ill.	Koch	126
5.68	35.89	49.27	9.16		11,920				Kofoed	127
5.50	40.41	40.26	13.83	4.80						128
15.60	27.60	49.66	7.14	2.22				University of Ill.	Rudy	129
6.15	33.63	42.78	17.44	7.25					L. Smith	130
7.00	34.00	47.45	11.15		11,664		L. Thompson	"	Clark	131
8.49	33.53	44.12	13.86		10,790					132
	36.70	48.20	15.10		12,771					133
12.00	32.30	42.50	13.80							134
3.42	39.30	53.20	4.08	1.72	12,240		L. Thompson	University of Ill.	Parr	135
4.65	30.85	59.80	4.70	1.70						136
8.22	39.40	43.95	8.43		12,169		L. Thompson	University of Ill.	McConney	137
5.87	34.03	48.50	11.60	3.87						138
8.36	34.19	46.88	10.57	2.59				University of Ill.	L. Smith	139
8.45	34.99	44.55	12.06		11,272		L. Thompson	"	McConney	140
7.50	31.30	49.50	11.70		11,718			"	Clark	141
10.92	27.60	46.64	14.84	4.99				"	Rudy	142
9.42	31.38	51.74	7.46	2.46						143
10.71	37.62	45.07	6.60	2.39					Eng. Club, St.L.	144
5.05	30.98	59.05	4.95	1.74						145
7.10	32.12	49.74	11.04		10,684				Forsyth	146
7.49	35.19	54.45	2.87		12,384					147
6.45	30.86	52.82	9.87	3.32						148
9.18	39.58	43.75	7.49		11,700		L. Thompson	University of Ill.	Parr	149
8.77	36.57	45.57	9.09					"		150
7.08	42.80	42.14	7.98					"		151
8.00	39.53	46.00	6.47					"		152
7.17	37.00	42.09	13.74		10,383			"		153
6.37	32.69	59.13	1.81	.76						154
6.12	24.68	66.58	2.70	.60	12,707		Cal. from ult. anal.	University of Ill.	Rudy	155
10.38	36.68	46.10	6.84	3.53						156
7.97	36.43	44.49	11.11		11,441		L. Thompson	University of Ill.	McConney	157
5.30	35.00	51.50	8.20		11,772			"	Clark	158
7.99	38.59	44.51	8.91					"		159
8.10	33.10	41.10	14.70							160
9.63	38.33	40.22	11.82	6.78	11,072		Parr	University of Ill.	Koch	161
7.68	35.52	46.53	9.97		11,360		L. Thompson	"	McConney	162
7.11	40.37	48.23	4.29		11,880			"	Parr	163
3.26	35.61	56.37	4.76	.76				"	Koch	164
3.71	36.25	50.30	9.74	1.50				Illinois Steel Co.		165
5.13	36.36	49.44	9.07	1.17						166
4.44	34.25	40.55	20.79		10,706		L. Thompson	University of Ill.		167
7.88	36.25	47.80	8.47		11,529			"	McConney	168
11.85	34.15	45.50	8.50		11,529			"	Clark	169
8.30	34.40	43.12	14.18	4.42	10,395				Eng. Club, St.L.	170
7.80	37.55	46.00	8.65		12,528		L. Thompson	University of Ill.	Rudy	171
6.20	40.25	46.02	7.53		11,880			"	Parr	172
6.32	37.73	44.45	11.50					"		173
7.10	34.90	48.09	9.91		11,250		L. Thompson	"		174
5.09	37.93	42.30	14.68		10,980			"		175
7.28	41.25	45.23	6.24		11,700			"		176
7.24	40.76	45.77	6.23		12,240			"		177
7.92	38.39	45.57	8.12		12,240			"		178
8.11	35.73	44.62	11.54		11,520			"		179
8.00	34.31	42.26	15.43		11,160			"		180
3.50	38.30	47.35	10.85		12,330			"		181
4.20	36.22	44.23	15.35		11,790			"		182
8.42	34.07	41.85	15.70		11,790			"		183
8.55	36.10	44.15	11.20		11,520			"		184
7.71	35.43	42.44	14.42		11,520			"		185
7.25	38.17	43.23	11.35	3.61	10,890			"	Koch	186
6.32	37.73	44.45	11.50		10,946			"	Parr	187
6.48	31.95	39.54	22.03					"		188
6.70	34.65	46.70	11.95	3.43				"	Johnson	189
4.70	33.78	46.05	15.47	4.80				"	Koch	190
6.07	33.99	50.86	9.08		11,954		L. Thompson	"	McConney	191
9.10	36.46	47.22	7.22		11,430			"	Parr	192

TABLE I.—*Chemical Analyses and Heating Values of Illinois Coals,*

Number.	LOCATION OF MINE.		Description of grade of coal used.	Geological number of seam.	DATE OF ANALYSIS.	
	Town.	County.			Month.	Year.
193	Odin	Marion		6		1889
194	"	"	Pea	6		1897
195	"	"	Lump	6		1897
196	"	"	Pea	6	May	1900
197	Oglesby	LaSalle	Vein sample, 2d vein			1878
198	"	"	Vein sample, 3d vein			1878
199	Pana	Christian		6		1889
200	"	"	Slack	6	March	1898
201	"	"	Pea	6		
202	"	"	Duff	6		
203	"	"	Nut	6	December	1902
204	Peoria	Peoria	Average	5		
205	"	"	Select	5		
206	Peru	LaSalle		2		1889
207	"	"	2d and 3d veins	2		1878
208	Pottstown	Peoria	Average	5		
209	"	"	Select	5		
210	Reinecke	St. Clair		6		
211	Ridgely	Sangamon		5	February	1899
212	"	"	Pea	5	March	1899
213	Riverton	"		5		
214	"	"		5		1889
215	"	"		5		1889
216	"	"		5	March	1899
217	"	"	Pea	5		
218	Rushville	Schuyler		5		
219	St. David	Fulton	Average	5		
220	"	"	Select	5		
221	"	"	Average	5		
222	"	"	Select	5		
223	St. Bernard	St. Clair		6		
224	St. John	Perry	Paradise lump	6	July	1896
225	"	"		6	February	1896
226	"	"		6		
227	"	"		6		
228	Sandoval	Marion		6		1889
229	Seatonville	Bureau		2		
230	Spaulding	Sangamon	Lump	5	February	1897
231	Springfield	"		5		1897
232	Springfield Junction	"		5	February	1899
233	Spring Valley	Bureau	Washed screenings	2	May	1899
234	Staunton	Macoupin		5		
235	"	"		5		
236	Streator	LaSalle	Lump	7		
237	"	"	Select	7		
238	"	"	Average	7		
239	"	"		7		
240	"	"		7		
241	"	"		7		
242	"	"	Lump	7		
243	"	"	Nut	7		
244	"	"	Screenings	7		
245	"	"		7		
246	"	"		7		
247	Sugar Creek	Wabash	Hand sample	15	January	1901
248	Sunnyside	Williamson	Washed No. 2	7		1902
249	Toluca	Marshall		2	July	1898
250	Trenton	Clinton		7		
251	"	"		7		
252	Virden	Macoupin	Nut	5		
253	Vulcan	St. Clair		6		
254	"	"		6		
255	Williamsville	Sangamon	Nut	5		
256	"	"	Pea	5		
257	Wilmington	Will.		2		
258	"	"	Lump	2		
259	"	"	Screenings	2		
260	"	"	Washed screenings	2		

† Borings, number of seam not determined.

Comprising 260 Tests from 94 Different Locations—Concluded.

PROXIMATE ANALYSES.					Sulphur.	British thermal units per pound of coal.	Calorimeter used.	AUTHORITY.		Number.
Moisture.	Volatile matter	Fixed carbon.	Ash.	Intitution.				Chemist.		
5.90	41.10	46.90	6.10	....	12.663	L. Thompson	University of Ill.	Clark	193	
6.48	31.95	39.54	22.03	4.31	11.194	Parr	University of Ill.	L. Smith	194	
6.81	37.05	44.23	11.91	2.68	11.194	Parr	University of Ill.	Koch	195	
7.27	35.76	42.96	14.01	3.88	11.194	Parr	University of Ill.	Rudy	196	
12.12	30.84	49.32	7.72	2.02	11.194	Parr	University of Ill.	Rudy	197	
10.06	30.34	55.88	3.72	2.27	11.194	Parr	University of Ill.	Rudy	198	
7.22	36.37	46.95	9.46	1.61	11.610	L. Thompson	University of Ill.	McConney	199	
8.55	35.45	39.35	16.65	4.77	9.810	L. Thompson	University of Ill.	Koch	200	
4.70	41.20	40.60	13.50	3.68	11.640	L. Thompson	Illinois Steel Co.	McConney	201	
4.88	35.59	40.11	19.42	3.58	11.640	L. Thompson	Illinois Steel Co.	McConney	202	
5.30	39.43	46.04	9.23	1.84	11.846	Parr	University of Ill.	Kofoed	203	
3.22	36.13	49.21	11.44	1.37	11.870	Parr	University of Ill.	Forsyth	204	
3.18	39.24	50.36	7.02	1.84	11.845	Parr	University of Ill.	Forsyth	205	
9.00	37.19	47.20	6.61	1.82	11.829	L. Thompson	University of Ill.	McConney	206	
10.30	33.90	51.26	4.54	3.05	10.790	L. Thompson	University of Ill.	Rudy	207	
4.58	35.52	45.42	14.38	1.79	11.640	L. Thompson	University of Ill.	Forsyth	208	
5.51	35.92	49.76	8.81	1.64	11.640	L. Thompson	University of Ill.	Forsyth	209	
7.56	39.81	42.49	10.14	4.02	11.640	L. Thompson	University of Ill.	Forsyth	210	
9.41	36.94	41.44	12.21	4.09	11.640	L. Thompson	University of Ill.	Koch	211	
9.80	37.33	40.04	12.83	4.19	11.640	L. Thompson	University of Ill.	Koch	212	
11.06	37.94	42.98	8.02	3.27	11.633	L. Thompson	University of Ill.	McConney	213	
6.38	35.39	48.45	9.78	1.63	12.096	L. Thompson	University of Ill.	McConney	214	
11.10	38.45	44.30	6.15	1.20	12.096	L. Thompson	University of Ill.	Clark	215	
8.83	36.51	40.56	14.10	4.22	11.700	L. Thompson	University of Ill.	Koch	216	
3.94	41.10	39.88	15.08	3.96	11.700	L. Thompson	Illinois Steel Co.	Koch	217	
6.00	34.60	52.90	6.50	3.00	10.732	L. Thompson	University of Ill.	Koch	218	
2.00	34.60	46.20	17.20	1.00	10.732	L. Thompson	University of Ill.	Forsyth	219	
3.07	35.88	52.59	8.46	1.83	11.833	L. Thompson	University of Ill.	Forsyth	220	
1.50	33.77	47.67	17.06	1.05	11.051	L. Thompson	University of Ill.	Forsyth	221	
1.38	37.42	55.89	5.31	1.38	12.384	L. Thompson	University of Ill.	Forsyth	222	
14.40	30.90	48.40	6.40	1.40	11.970	L. Thompson	University of Ill.	Eng. Club, St. L.	223	
9.63	37.00	51.10	2.27	1.97	11.700	L. Thompson	University of Ill.	Parr	224	
10.72	34.56	48.34	6.38	1.70	11.700	L. Thompson	University of Ill.	Parr	225	
9.82	28.35	45.75	16.08	2.06	9.768	L. Thompson	University of Ill.	Eng. Club, St. L.	226	
13.60	24.46	46.54	15.40	1.83	9.828	L. Thompson	University of Ill.	Eng. Club, St. L.	227	
7.19	35.07	50.86	6.88	1.95	11.959	L. Thompson	University of Ill.	McConney	228	
10.00	33.80	40.90	15.30	1.95	11.959	L. Thompson	University of Ill.	McConney	229	
12.47	35.44	40.57	11.52	1.98	10.980	L. Thompson	University of Ill.	Parr	230	
10.45	35.89	41.68	11.98	2.99	10.980	L. Thompson	University of Ill.	L. Smith	231	
9.11	37.04	43.62	10.33	3.65	10.980	L. Thompson	University of Ill.	Koch	232	
12.40	35.58	39.01	13.01	2.81	10.980	L. Thompson	University of Ill.	Koch	233	
6.27	57.11	26.30	10.32	1.81	11.508	Carpenter	University of Ill.	Koch	234	
*	36.00	48.00	16.00	1.50	11.508	Carpenter	University of Ill.	Carpenter	235	
4.45	39.19	44.05	12.31	1.39	11.399	Carpenter	University of Ill.	Forsyth	236	
2.16	40.20	54.97	2.67	1.17	13.147	Carpenter	University of Ill.	Forsyth	237	
8.30	37.63	45.93	8.14	1.47	11.476	Carpenter	University of Ill.	Forsyth	238	
8.40	38.25	47.10	6.25	1.72	11.727	Carpenter	University of Ill.	Forsyth	239	
6.87	32.43	49.70	11.20	3.12	11.420	Carpenter	University of Ill.	Forsyth	240	
12.01	35.32	48.78	3.89	2.38	11.420	Carpenter	University of Ill.	Eng. Club, St. L.	241	
*	39.40	48.20	12.40	1.61	12.614	Carpenter	University of Ill.	Carpenter	242	
*	35.60	54.50	9.90	1.79	12.794	Carpenter	University of Ill.	Carpenter	243	
*	31.40	42.20	26.40	10.304	12.155	Carpenter	University of Ill.	Carpenter	244	
*	39.60	45.40	15.00	12.155	11.590	Carpenter	University of Ill.	Carpenter	245	
*	38.40	43.80	17.80	11.590	11.590	Carpenter	University of Ill.	Carpenter	246	
6.03	41.30	48.79	3.88	1.73	12.488	Parr	University of Ill.	Koch	247	
3.97	33.86	55.28	6.89	1.48	10.800	L. Thompson	University of Ill.	Parr	248	
8.95	33.07	41.32	16.66	4.64	10.800	L. Thompson	University of Ill.	Wolcott	249	
13.30	30.40	52.00	4.30	10.588	11.234	L. Thompson	University of Ill.	Eng. Club, St. L.	250	
9.95	31.04	51.96	7.05	1.00	11.234	L. Thompson	University of Ill.	Eng. Club, St. L.	251	
5.15	40.82	43.54	10.49	3.78	9.450	L. Thompson	Illinois Steel Co.	Eng. Club, St. L.	252	
7.44	30.86	45.09	16.61	1.30	10.625	L. Thompson	Illinois Steel Co.	Eng. Club, St. L.	253	
10.30	27.90	49.00	12.80	4.70	10.625	L. Thompson	Illinois Steel Co.	Eng. Club, St. L.	254	
2.45	43.50	41.69	12.36	4.20	12.360	L. Thompson	Illinois Steel Co.	Eng. Club, St. L.	255	
2.65	42.25	42.62	12.48	3.70	12.360	L. Thompson	Illinois Steel Co.	Eng. Club, St. L.	256	
7.12	32.11	49.46	11.25	3.40	12.180	Carpenter	University of Ill.	Carpenter	257	
*	36.80	49.90	13.30	12.180	9.544	Carpenter	University of Ill.	Carpenter	258	
*	32.60	39.70	27.70	9.544	12.026	Carpenter	University of Ill.	Carpenter	259	
*	34.50	50.20	15.30	12.026	12.026	Carpenter	University of Ill.	Carpenter	260	

* Dried.

TABLE II.—*Ultimate Analyses, Heat Value, from*

Number in Table I.	LOCATION OF MINES.		Description or grade of coal used.	Geological number of seam.	Year of analyses.
	Town.	County.			
19	Bloomington.....	McLean.....	Vein sample..	5	1878
29	Carbondale.....	Jackson.....	" ..	7	"
78	DuQuoin.....	Perry.....	" ..	6	"
155	Mt. Carbon.....	Jackson.....	" ..	2	"

TABLE III.—*Sulphur in Illinois*

Number in Table I.	LOCATION OF MINES.		Description or grade of coal used.	Geological number of seam.	Year of analyses.
	Town.	County.			
10	Barclay	Sangamon....	Vein sample.....	5	1878
19	Bloomington	McLean	" ..	5	"
22	Briar Bluff.....	Henry.....	" ..	1	"
29	Carbondale.....	Jackson	" ..	7	"
33	Cartersville.....	Williamson ..	Mine run.....	7	1900
34	Cartersville.....	" ..	No. 1, washed.....	7	"
41	Catlin.....	Vermilion	Vein sample.....	7	1878
55	Danville	" ..	" ..	7	"
78	DuQuoin.....	Perry	" ..	6	"
102	Elmwood.....	Peoria.....	" ..	2	"
108	Farmington	Fulton	" ..	5	"
122	Grape Creek.....	Vermilion	" ..	6	"
129	Kewanee.....	Henry	" ..	6	"
142	Lincoln.....	Logan	" ..	5	"
143	Lombardville.....	Bureau.....	" ..	†	"
155	Mt. Carbon.....	Jackson	" ..	2	"
197	Oglesby.....	LaSalle.....	" 2d vein.....	"	"
198	Oglesby.....	" ..	" 3d vein.....	"	"
207	Peru	" ..	" 2d&3d v.	2	"

† Borings, number of seam not determined.

Special Tests of Vein Samples, Illinois Coals.

ULTIMATE ANALYSIS.				Sulphur.	Ash.	British thermal units calculated	Authority.
Carbon.	Hydrogen.	Oxygen.	Nitrogen.				
65.36	5.94	17.16	1.59	1.97	4.96	12,318	W. D. Rudy.....
69.52	5.42	15.31	1.55	0.80	7.40	12,323	".....
65.40	5.14	19.06	1.52	1.88	7.00	11,260	".....
72.98	5.39	16.65	1.68	0.60	2.70	12,707	".....

Coals, Special Tests, Vein Samples.

Sulphur in coal,	PERCENTAGE OF			Sulphur per cent of coke	AUTHORITY.	
	Original coal as sulphur in coke.	Original coal as volatile sulphur	Total sulphur remaining in coke.		Institution.	Chemist.
3.21	1.37	1.84	42.60	2.21	University of Illinois....	W. D. Rudy
1.97	.76	1.21	38.60	1.30	".....	"
4.62	1.51	3.11	32.70	2.21	".....	"
.80	.48	.32	60.00	.71	".....	"
.85	.38	.48	44.10	.62	".....	F. C. Koch.
.74	.26	.48	35.10	.42	".....	"
3.46	.61	2.85	17.60	.99	".....	W. D. Rudy
2.72	.43	1.29	15.80	.72	".....	"
1.88	.99	.89	50.00	1.46	".....	"
2.18	.77	1.41	35.30	1.18	".....	"
3.28	.84	2.44	25.60	1.35	".....	"
3.63	.97	2.66	26.70	1.57	".....	"
2.22	.81	1.38	38.00	1.47	".....	"
4.99	2.43	2.56	48.70	3.95	".....	"
2.46	.71	1.75	28.80	1.19	".....	"
.60	.40	.20	66.60	.57	".....	"
2.02	.68	1.34	33.60	1.19	".....	"
2.27	1.42	.85	62.50	2.38	".....	"
3.05	.83	2.22	27.20	1.48	".....	"



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